BREACH III: Evaluating and Predicting 'Restoration Thresholds' in Evolving Freshwater-Tidal Marshes

Steve Crooks on behalf of the BREACH III team

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Overview

- Broad Context
  - DRERIP and BDCP Conservation Strategy
  - Lower Yolo Bypass Planning Forum
- Liberty Island
  - Landscape Setting, Environmental Conditions
- Breach III
  - Goals and Objectives
  - Scope and Timelines
  - Anticipated Outcome
  - Linkages to Other Studies

Broad Context

- Large-scale interdisciplinary scientific study
  - key landscape location
  - builds on existing science
- DRERIP Conceptual models
  - Fill information gaps
  - Address key questions
- Inform large-scale restoration planning
  - BDCP Conservation Strategy
    - e.g. value of shallow subtidal habitat
    - e.g. habitat evolution projections
    - e.g. water management of the Yolo Bypass

DRERIP: Tidal Reintroduction

The value of tidal reintroductions for covered fish species will be strongly influenced by location, landscape setting, and site specific design considerations such as elevation, tidal exchange, substrate, sediment supply, turbidity, geomorphology, wind-wave regime, and connectivity to aquatic and upland environments. Careful siting and design can influence the likelihood of species benefits as well as the potential adverse effects of non-native invasive such as *Egeria* and associated predation risk.

DRERIP: Key Uncertainties

- Habitat use by native fish.
- Importance of productivity contributions from vegetated tidal marsh directly or indirectly to covered species.
- Relative benefits of vegetated tidal marsh vs. open water (and thus how to address subsided properties).
- Conditions that promote vs. discourage *Egeria* establishment.
- Extent to which invasive clams may divert considerable quantities of new primary production, magnitude of suitable productivity (zooplankton and insects) exported from restoration areas.
- Ability of natural processes to establish channels in restored marshes.

DRERIP Research Need

- Run (and life-history) specific studies of Central Valley Chinook salmon and studies of steelhead use of tidal marsh habitats would be extremely valuable to defining magnitude of impacts to these populations and increasing certainty. [splittail]

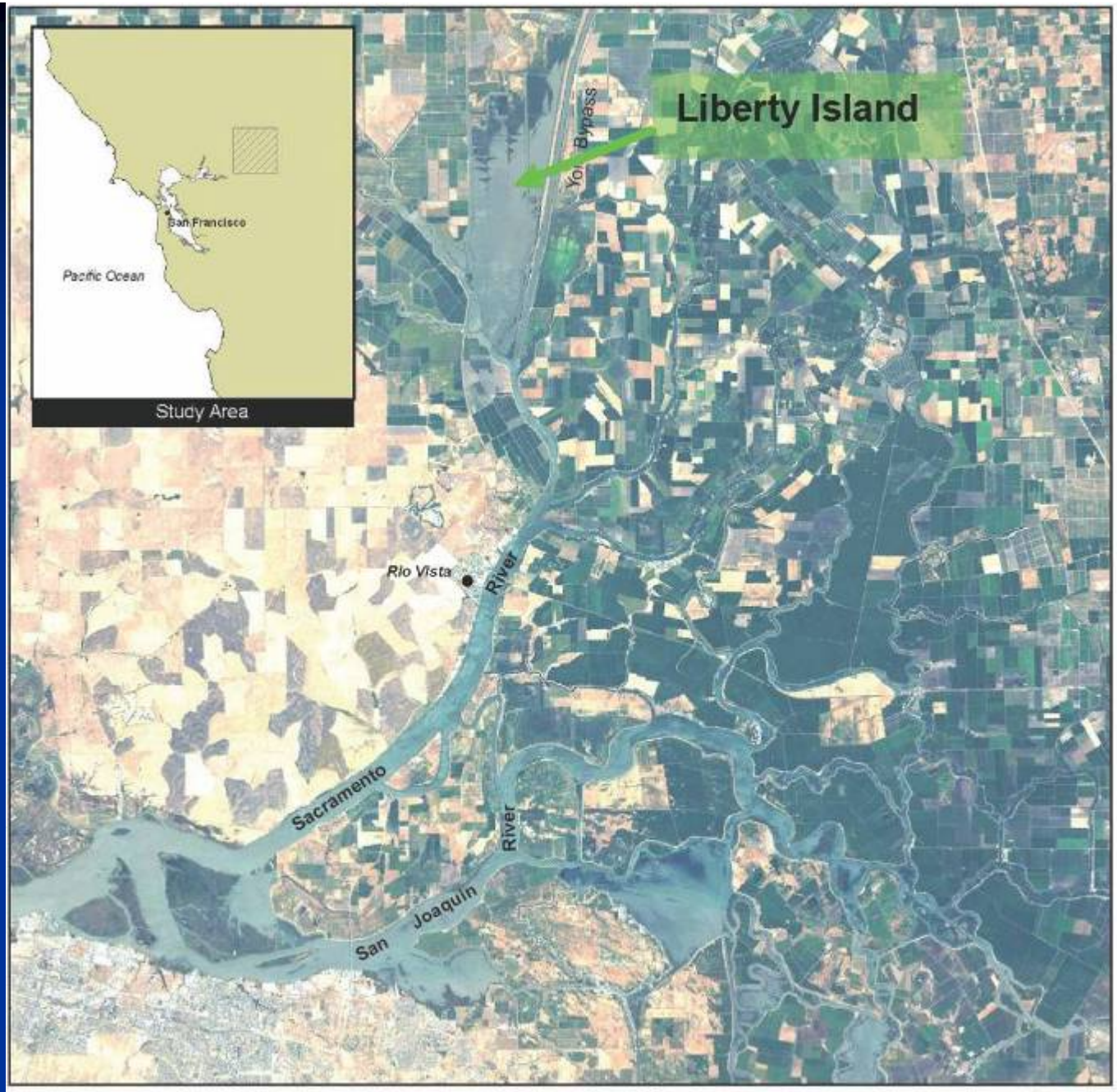
- Availability and production of food in tidal marshes. Export of organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta has not been studied.

DRERIP Research Need

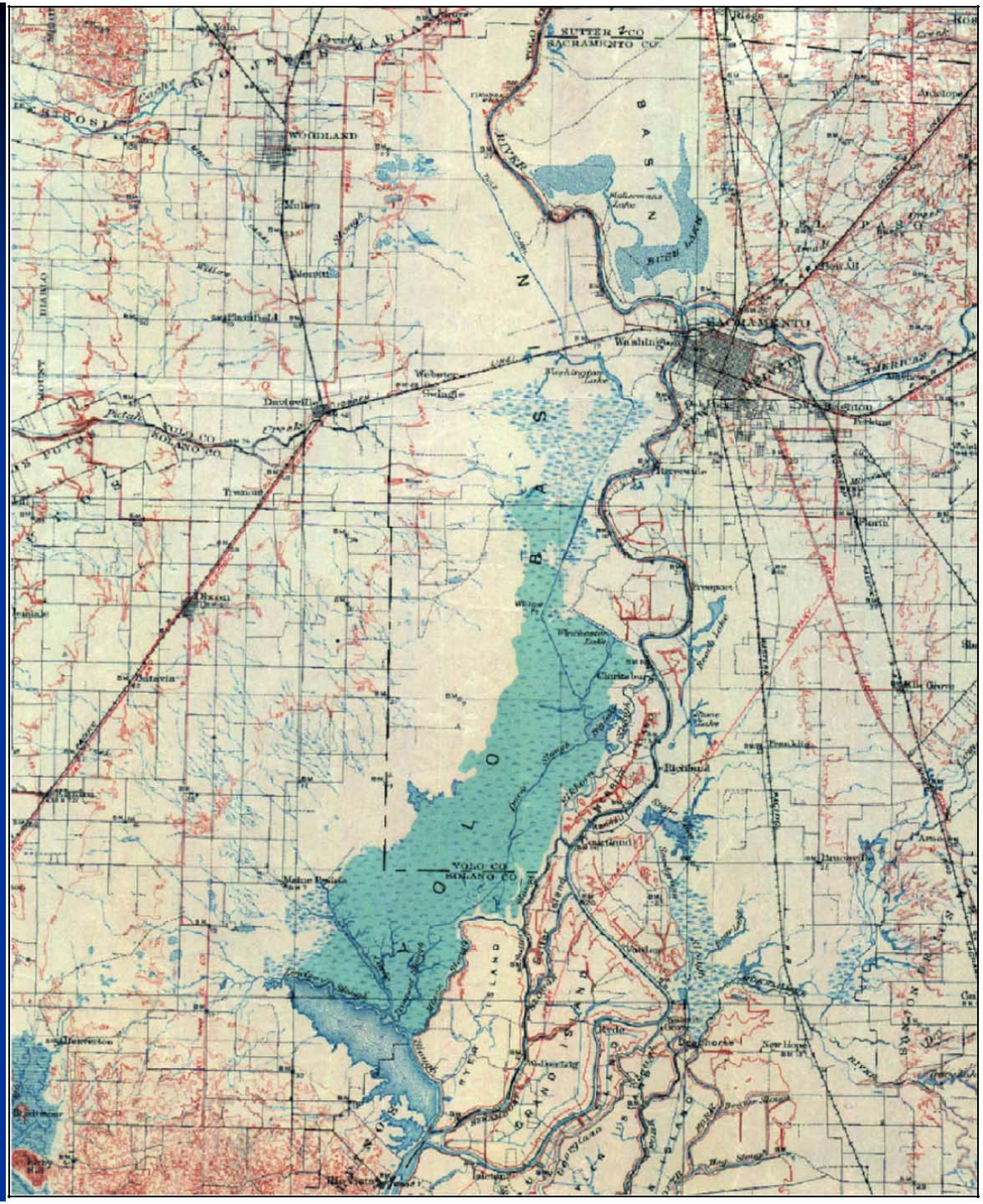
- Tropho-dynamic model of ecological interactions linking primary production to the food web structure and production flows into, through, and out of the tidal marsh system.

- Landscape-level models that address the effects of variation in structural features of the tidal marsh environment (e.g., tidal channel complexity, channel width, channel length, edge: area ratios, etc.) on the population or production dynamics of specific plants and animals.

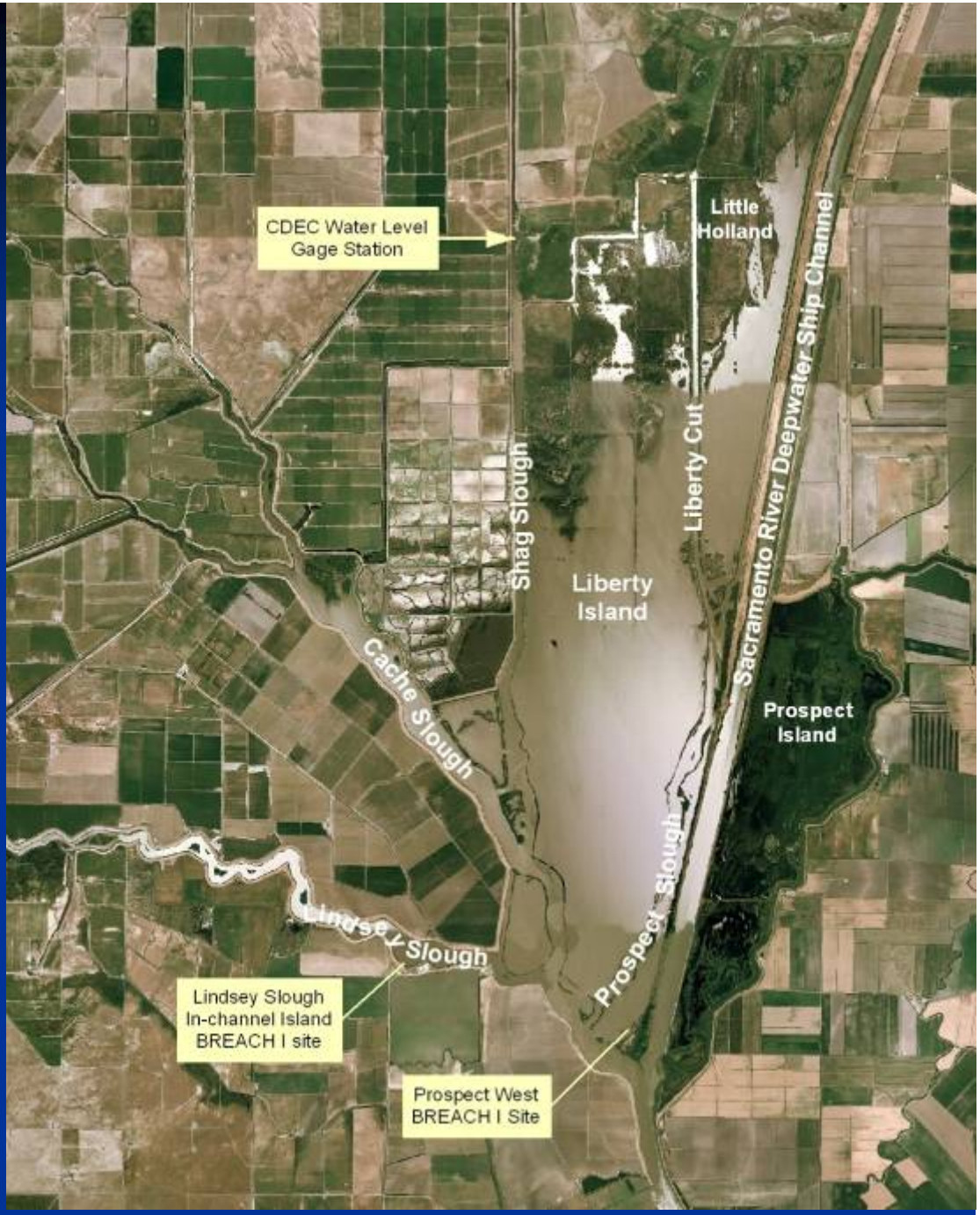
Location


Liberty Island
Yolo Bypass
San Francisco
Pacific Ocean
Study Area
Rio Vista
Sacramento River
San Joaquin River
Landsat Imagery and data layers courtesy of
California Spatial Information Library
http://gis.ca.gov
Kilometers
0 37.5 75 150 225 300

Yolo Bypass

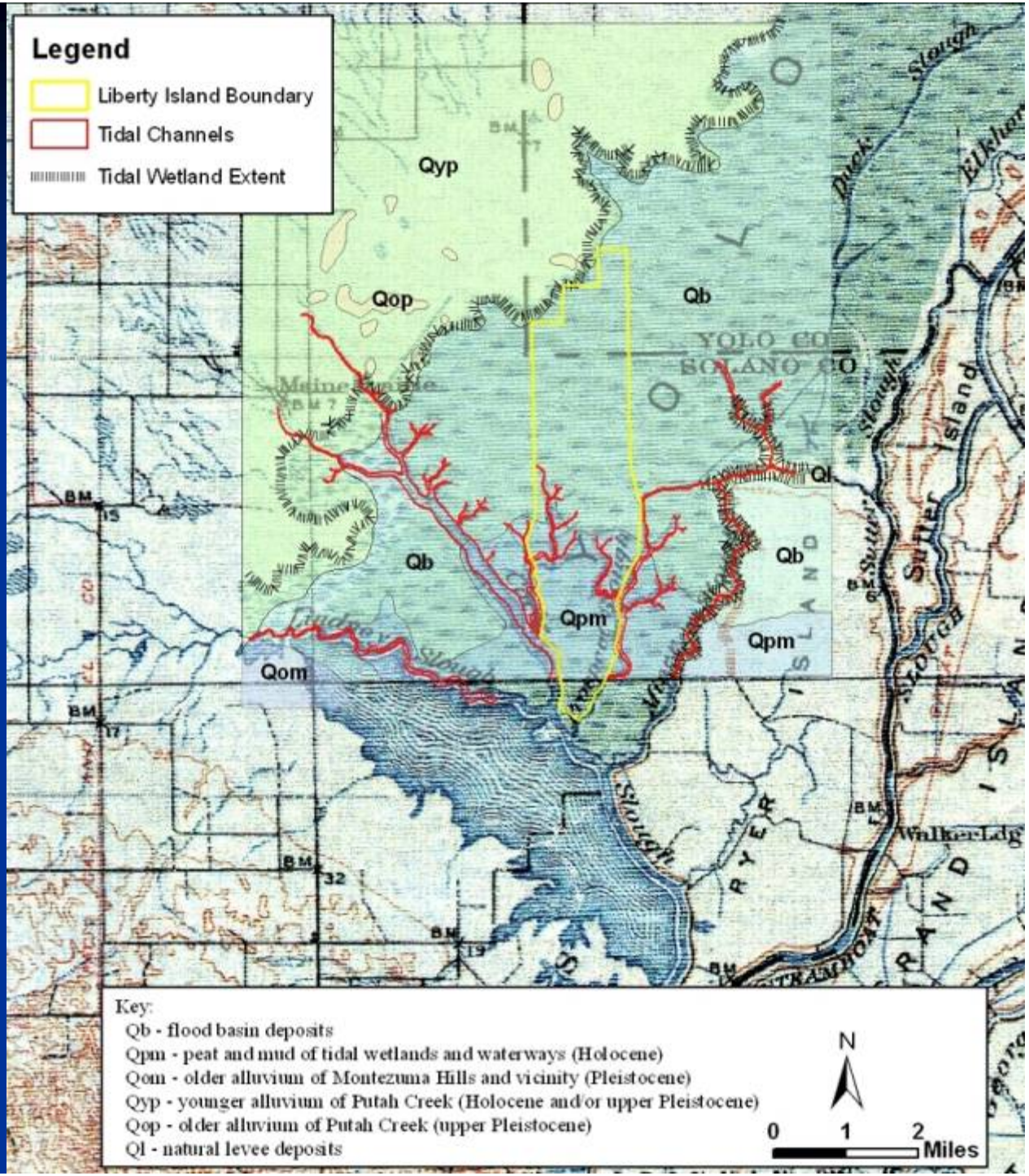


(USGS 1903-1910)



Source: National Agricultural Imagery Program

Basemap: USGS 1903-1910) Geologic Map and Historic Channels digitized by DWR from Atwater 1982.

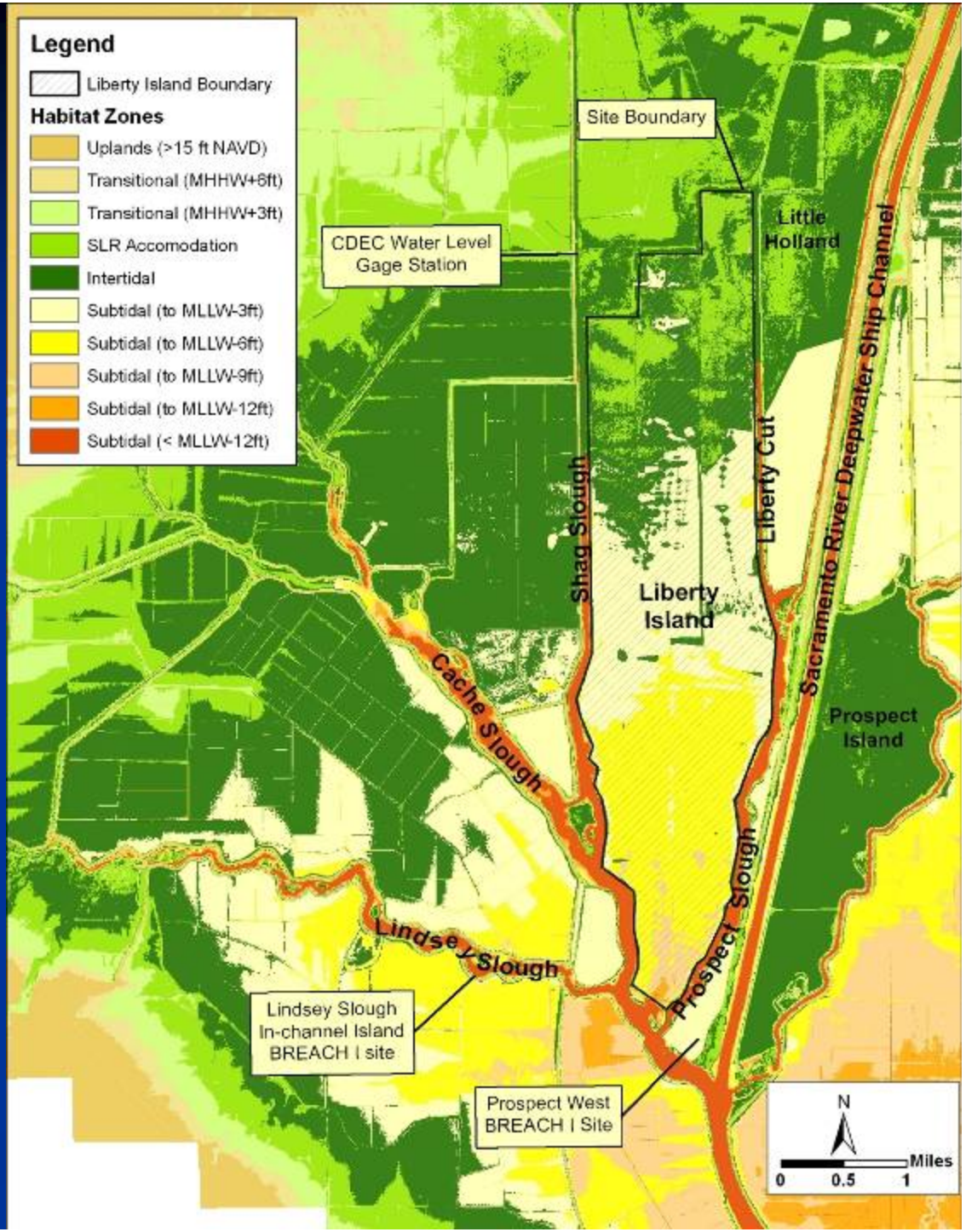


Cache Slough Topography

Elevation grid generated in support of BDCP habitat conservation planning process.

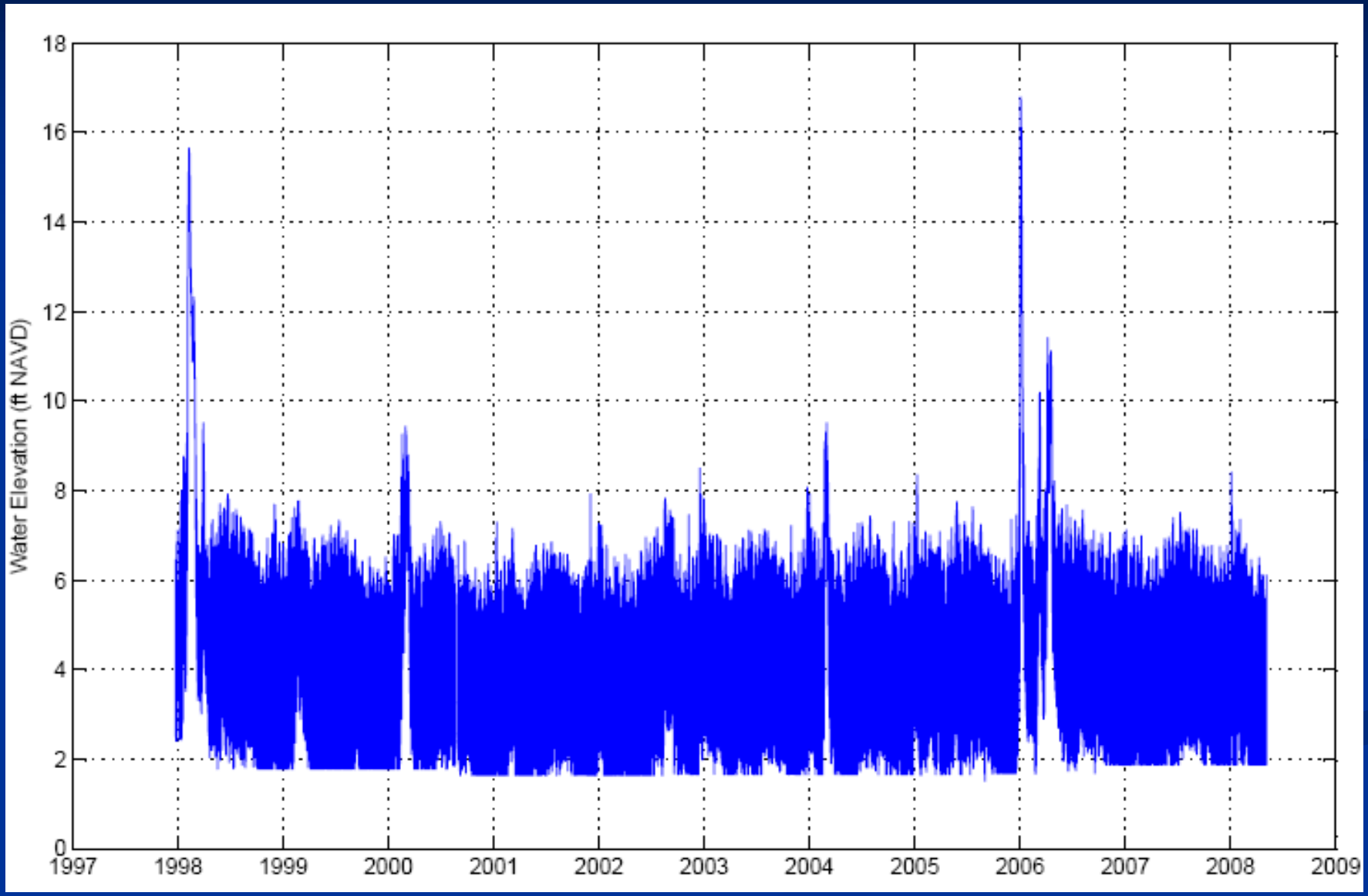
Source:
DWR LiDAR (2007-2008) and DWR 2003 Liberty Island bathymetry survey.

Approx. elevation include for Little Holland (lower area), Little Hastings and Cache Slough Mitigation Bank



Liberty Island

Cache Slough Hydrology



Source: DWR California Data Exchange Center (CDEC). Station Liberty Island Yolo Bypass (LIY)

Duration of large flood events

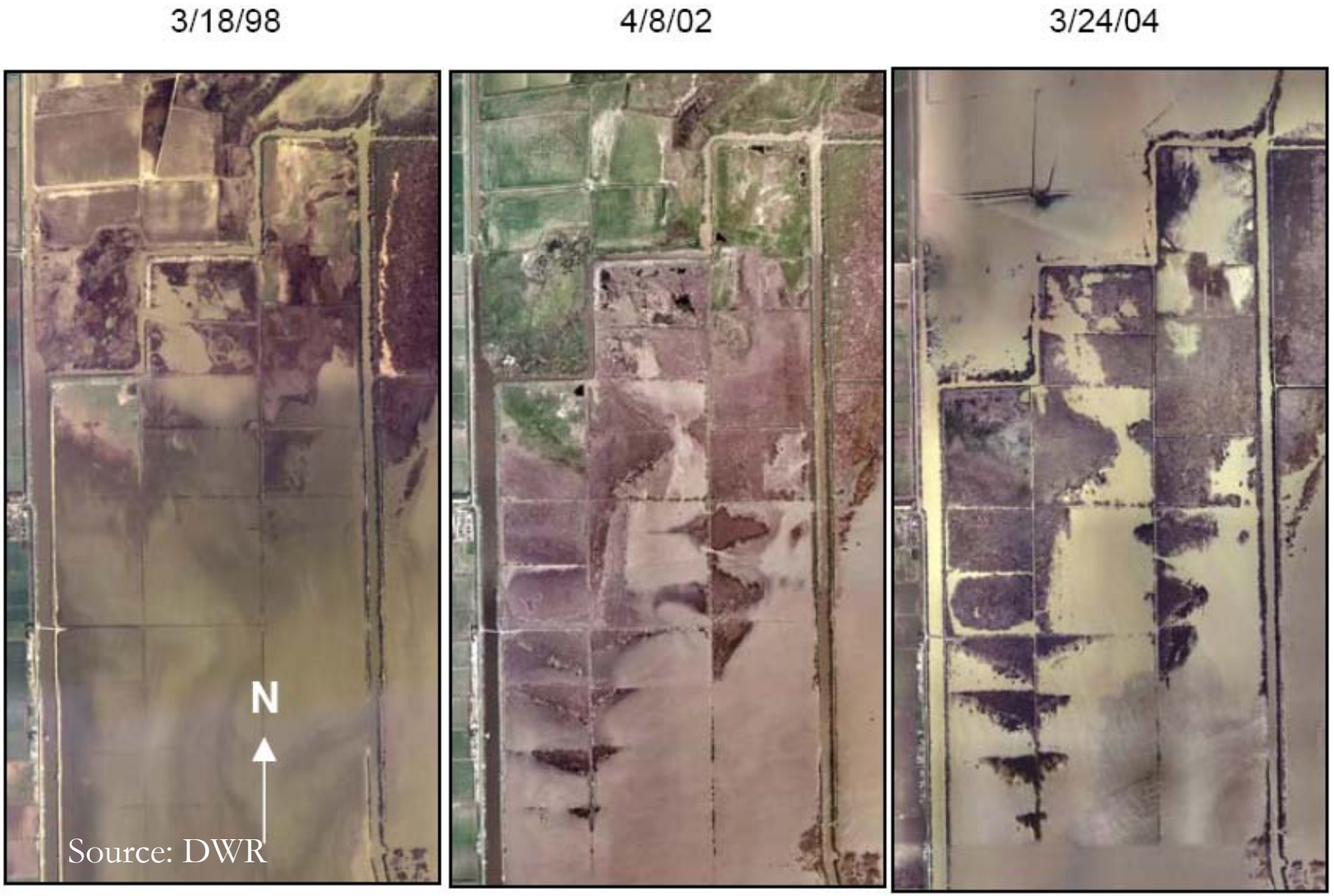
Table 2. Flood Events Exceeding Threshold Elevation for a Duration of 7 days (1997 to 2008)

Elevation (ft NAVD)	# Events	Date / Duration							
10	2	03-Feb-98 26 days	31-Dec-05 9 days						
9	3	03-Feb-98 27 days	31-Dec-05 11 days	13-Apr-06 7 days					
8	3	03-Feb-98 28 days	31-Dec-05 12 days	12-Apr-06 9 days					
7	3	02-Feb-98 29 days	30-Dec-05 13 days	04-Apr-06 17 days					
6	5	31-Jan-98 32 days	27-Feb-00 14 days	25-Feb-04 9 days	30-Dec-05 14 days	03-Apr-06 19 days			
5	6	31-Jan-98 35 days	25-Feb-00 18 days	22-Feb-04 13 days	30-Dec-05 17 days	04-Mar-06 9 days	03-Apr-06 20 days		
4	8	18-Jan-98 8 days	29-Jan-98 39 days	25-Mar-98 10 days	15-Feb-00 29 days	21-Feb-04 15 days	30-Dec-05 18 days	03-Mar-06 15 days	26-Mar-06 35 days

Source: DWR California Data Exchange Center (CDEC). Station: Liberty Island Yolo Bypass (LIY). River stage data for DWR station LIY spans 12/23/97 to 5/5/08. The data were converted from NGVD29 to NAVD88 with a conversion factor of 2.40 ft.

Data compiled by PWA

Rapid change, then slow



Slow development of vegetation observable at Little Holland.

Source: USFWS

Elevation range of lower tule edge, North Delta

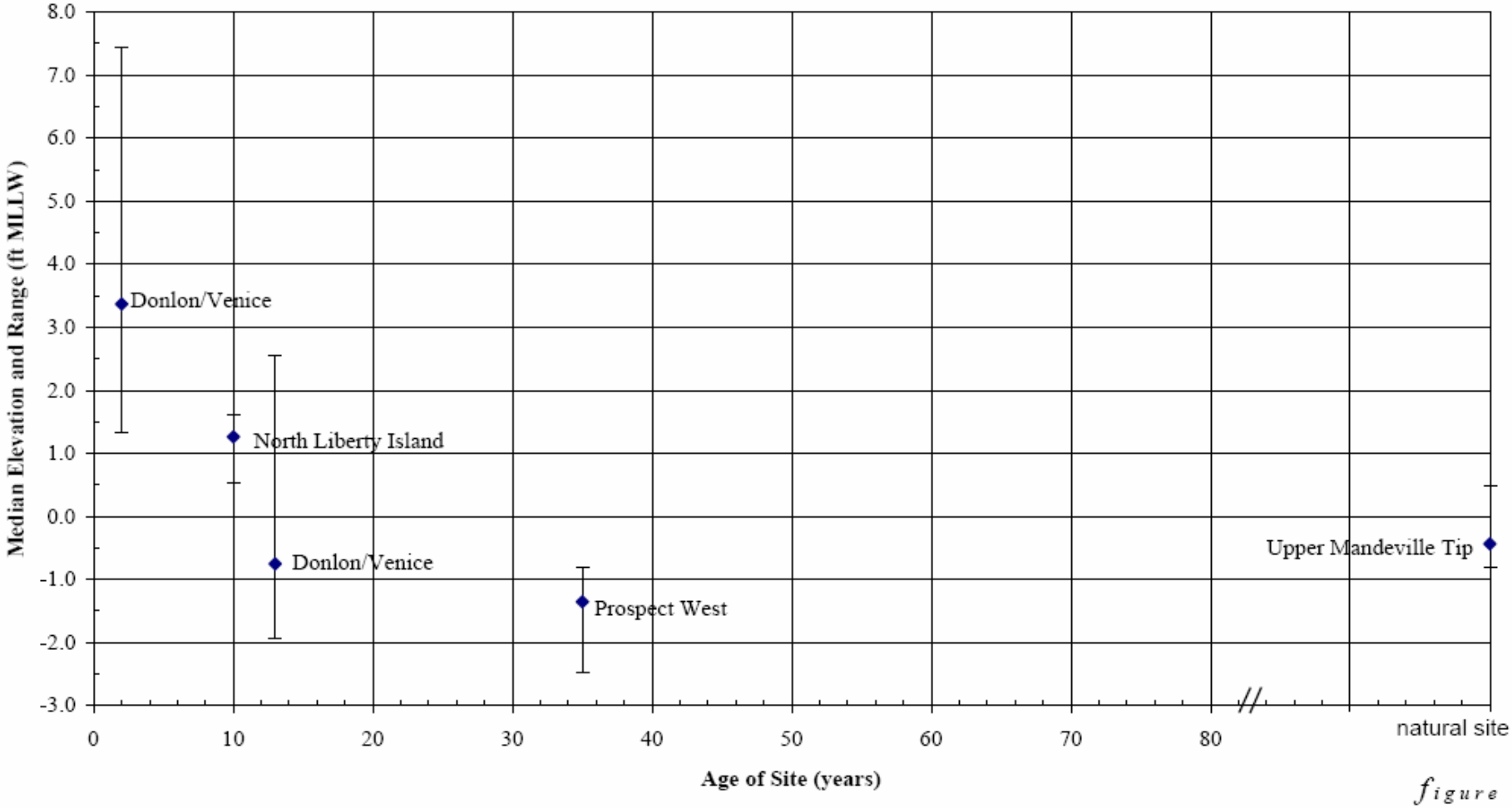


figure 15

Source: Simenstad et al. 2000

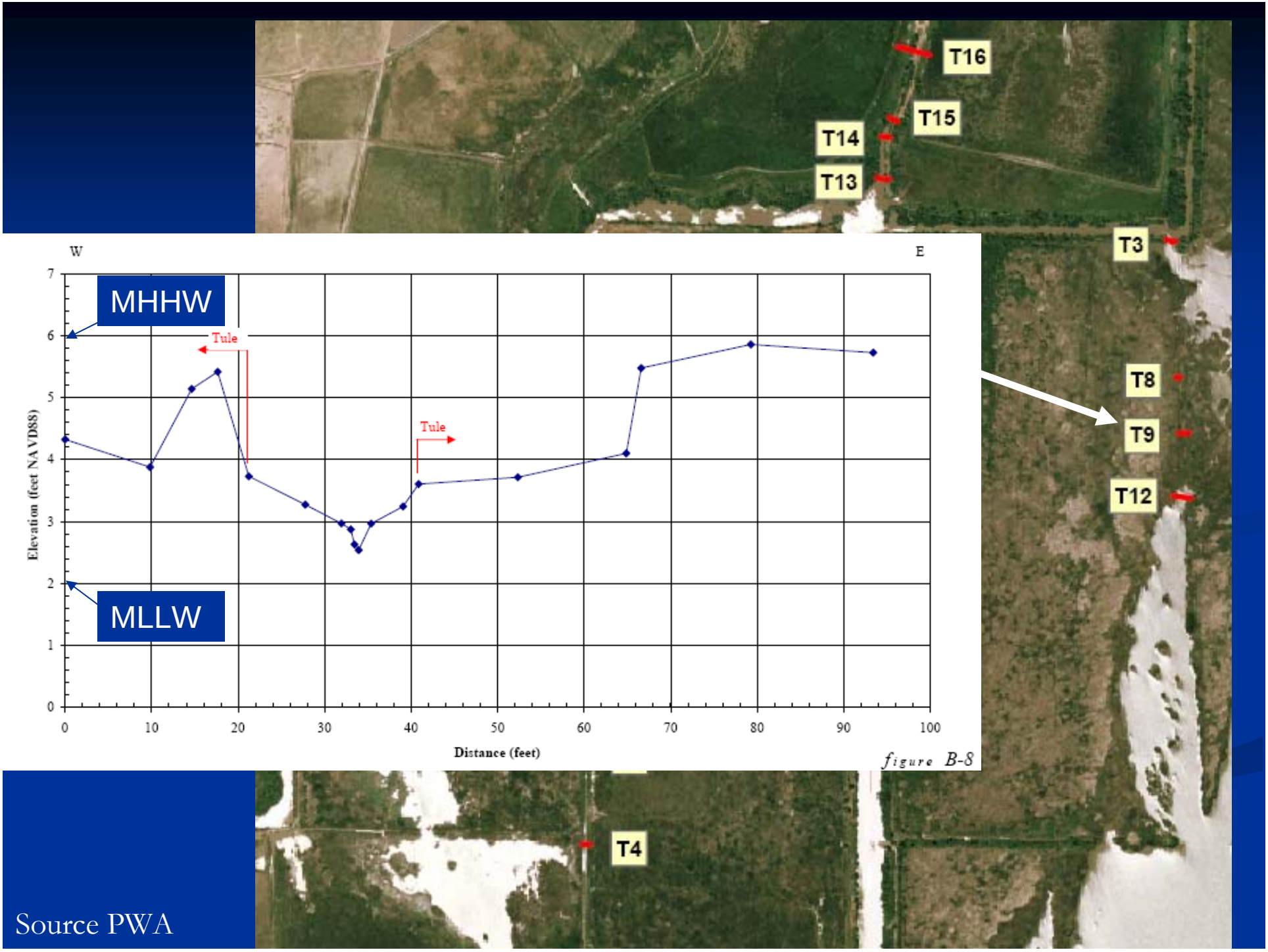


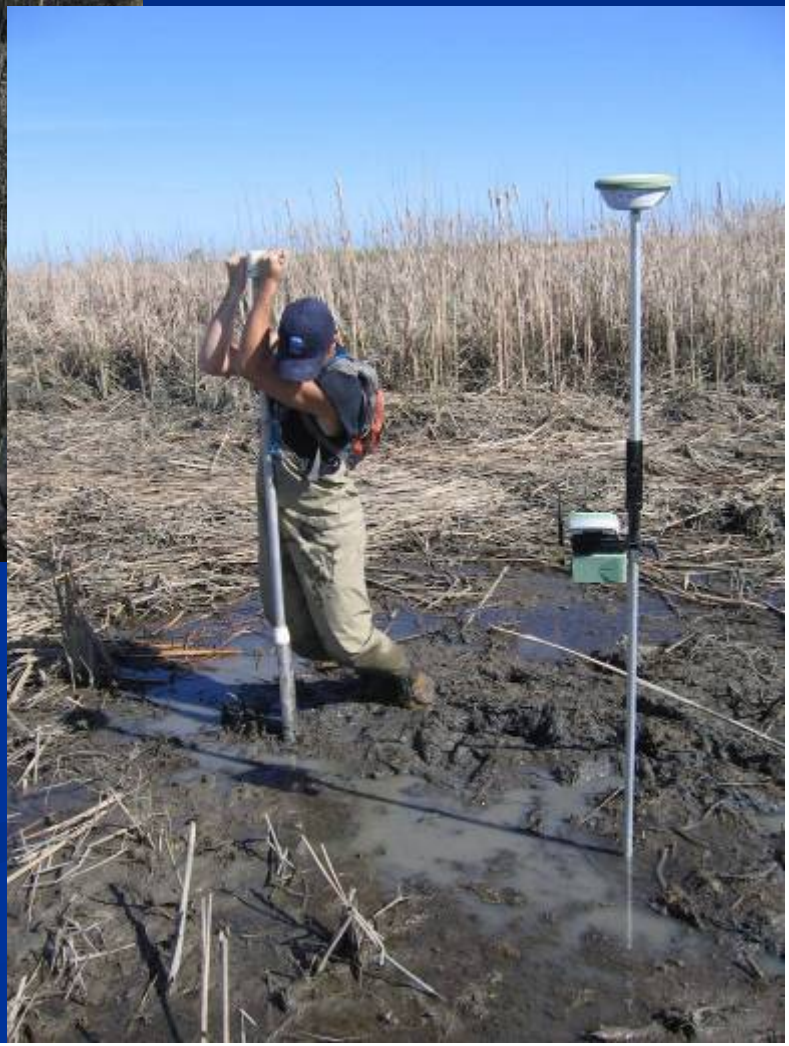
figure B-8

Source PWA

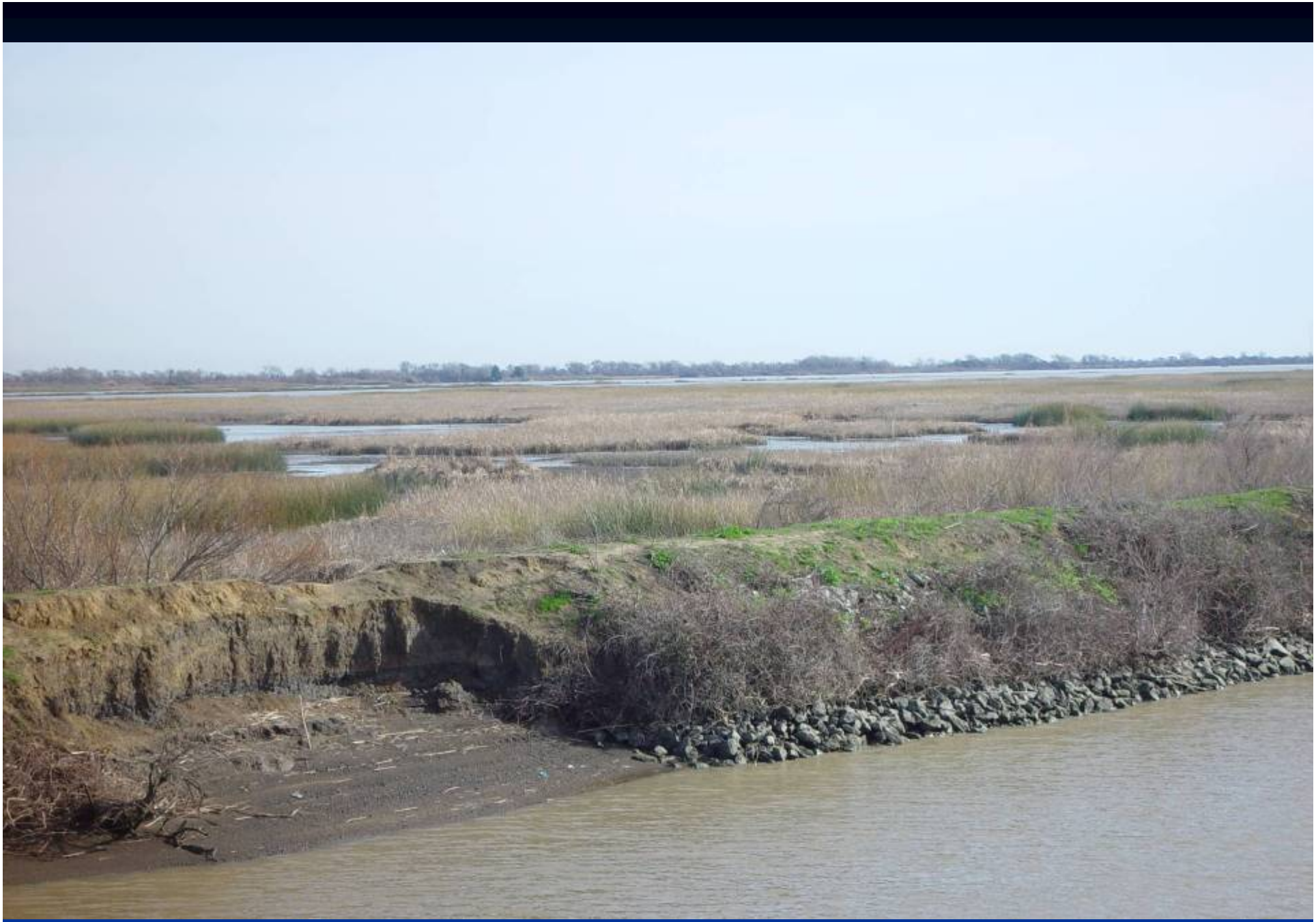
Upper Liberty Island


Upper Liberty Island

Upper Liberty Island



Vegetation colonization of firm substrate



Transitional Liberty Island

Transitional Liberty Island

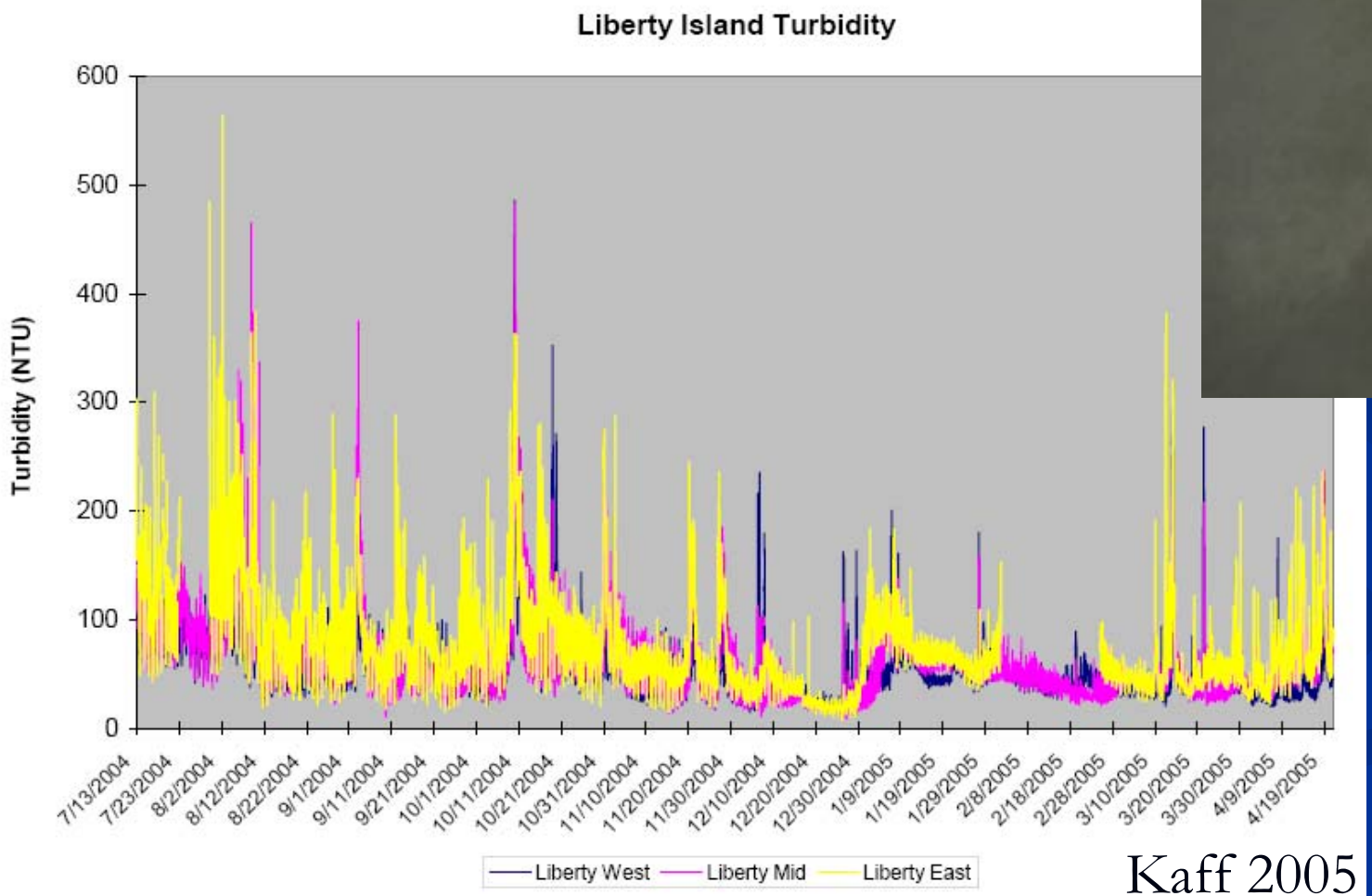
Lower Liberty Island

- Shallow open water
- Waves
- Eroding levees

Lower Liberty Island

Lower Liberty Island

Relatively high turbidity



Kaff 2005

Breach III

- **Flood & Erosion Hazards**

  (12 month study)
- **Interdisciplinary Science**

  (3 year study)

Flood & Erosion Hazard Analysis

- How have flood elevations in lower Yolo Bypass been affected by levee breach
- Assess how flood elevations might be affected by future geomorphic evolution
- Management approaches to improve conveyance, if desirable.
- Wave erosion risk assessment.
- Methods to limit wave erosion.

Liberty Island levy modifications after flooding event Jan 06

**NOTE: Flows in the Yolo Bypass are still too high to assess whether these new breaks will allow water to flow during a normal tidal cycle

1. New break; Water currently flowing over levy (approx. 250 m with high water levels)
2. New break
3. New break
4. New break
5. Breaks every 50-100 m (below bridge), not all have water running
6. This breach is 75 m wider now
7. Extensive erosion, vegetation (i.e., trees) is missing, extent will not be known until water levels decrease
8. New break (~100m wide)
9. New break (likely caused by water exiting southward out of Little Holland)
10. New break
11. New break

Record by USFWS

BREACH III: Science Goal

Provide through a combination of observation, experiments and modeling a predictive level of understanding about biotic and the abiotic controls on vegetation colonization and expansion in restoring wetlands, and the ecological response of native fish and wildlife species of concern to the evolving wetland features at the landscape scale

BREACH III: Objectives

- Understand site attributes and processes that influence initial vegetation colonization as critical “threshold” restoration process.
- Contrast and compare the effect of different unvegetated-vegetated pathways on biota
- Understand hydrologic and geomorphic changes and the ecological response in restoring wetlands at the landscape scale
- Develop predictive tools as templates for application in future CALFED restoration planning and projects

Breach III: Hypotheses

- Conditions and processes that initiate emergent marsh vegetation, colonization are deterministic and can be predicted.
- Landscape setting influences the geomorphic and habitat evolution of a restoring wetland.
- Tidal channel development influences the patterns of emergent vegetation colonization and associated fauna.
- Landscape structure (e.g. vegetation patches, unvegetated corridors, channel networks) dictate nekton distribution and behavior at multiple scales.
- Hydrogeomorphic events (floods, storms) precipitate punctuated changes and shifts in landscape development patterns and biota

Breach III Tasks

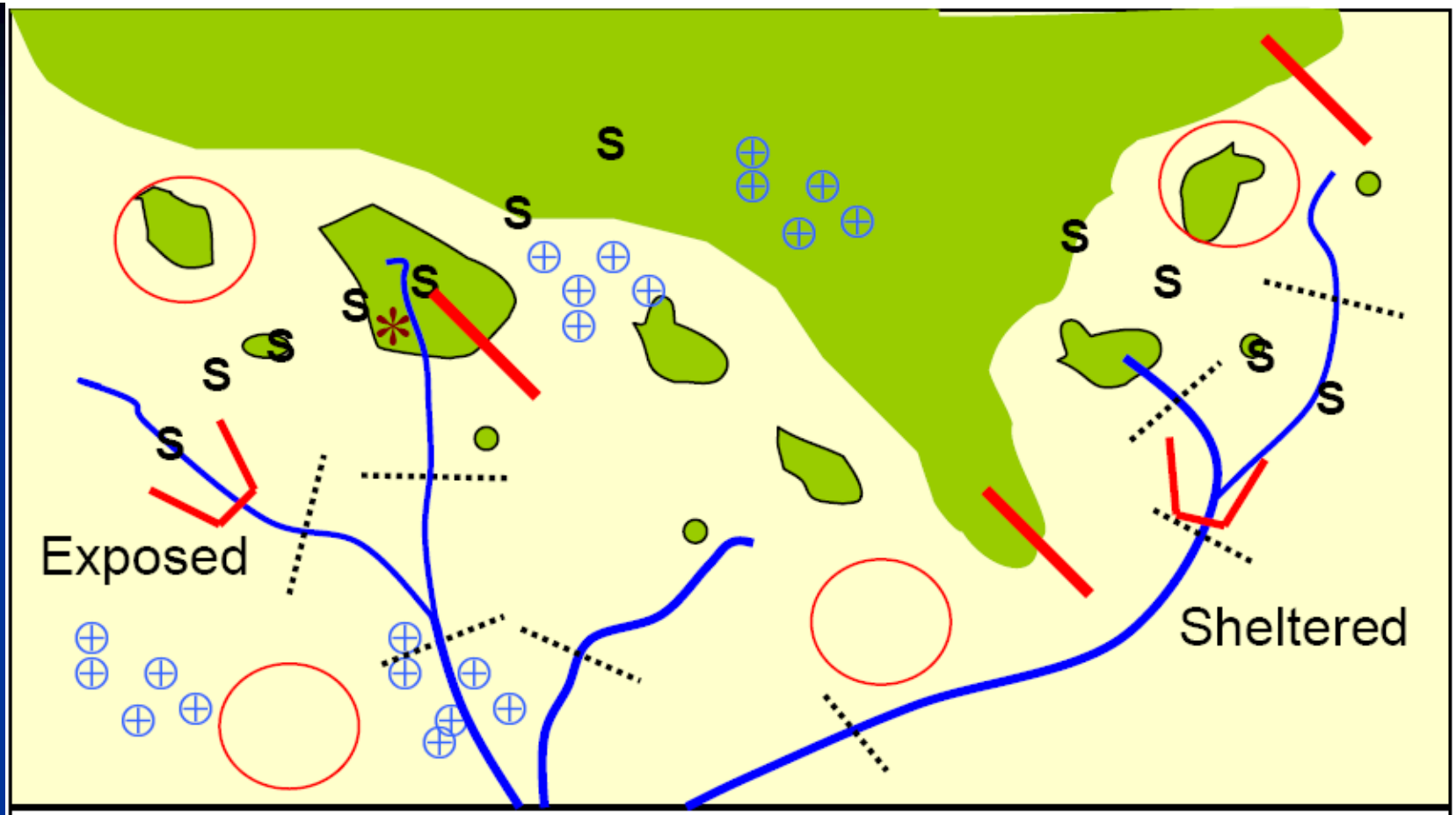
1. Channel / tidal flat morphology and wave climate
2. Landscape structure and change
3. Elevation change
4. Plant colonization dynamics
5. Macroinvertebrate response
6. Nekton response
7. Foodweb source and pathways
8. Hydrodynamics and sediment transport modeling
9. Landscape ecological modeling
10. Synthesis

Strategy and Approach

- Integrated field-modeling investigations of ecosystem processes regulating critical thresholds. 3 Blitz:
  - Wet conditions (Jan – March, max native fish)
  - Transitional (April, Migration Juv Salmon, Spawning of Delta Smelt)
  - Dry conditions (Late July – August, max veg)
- Opportunistic examination of punctuated events effects

BREAC III Sampling Locations

- Unvegetated flats
- Leading edge of emergent plant colonization
- Densely vegetated zone (some unvegetated patches and channels)
- Heavily vegetated (no channels)



⊕ Macroinvertebrate sampling points

Gill net sets

Channel cross sections

Channel fyke net sets

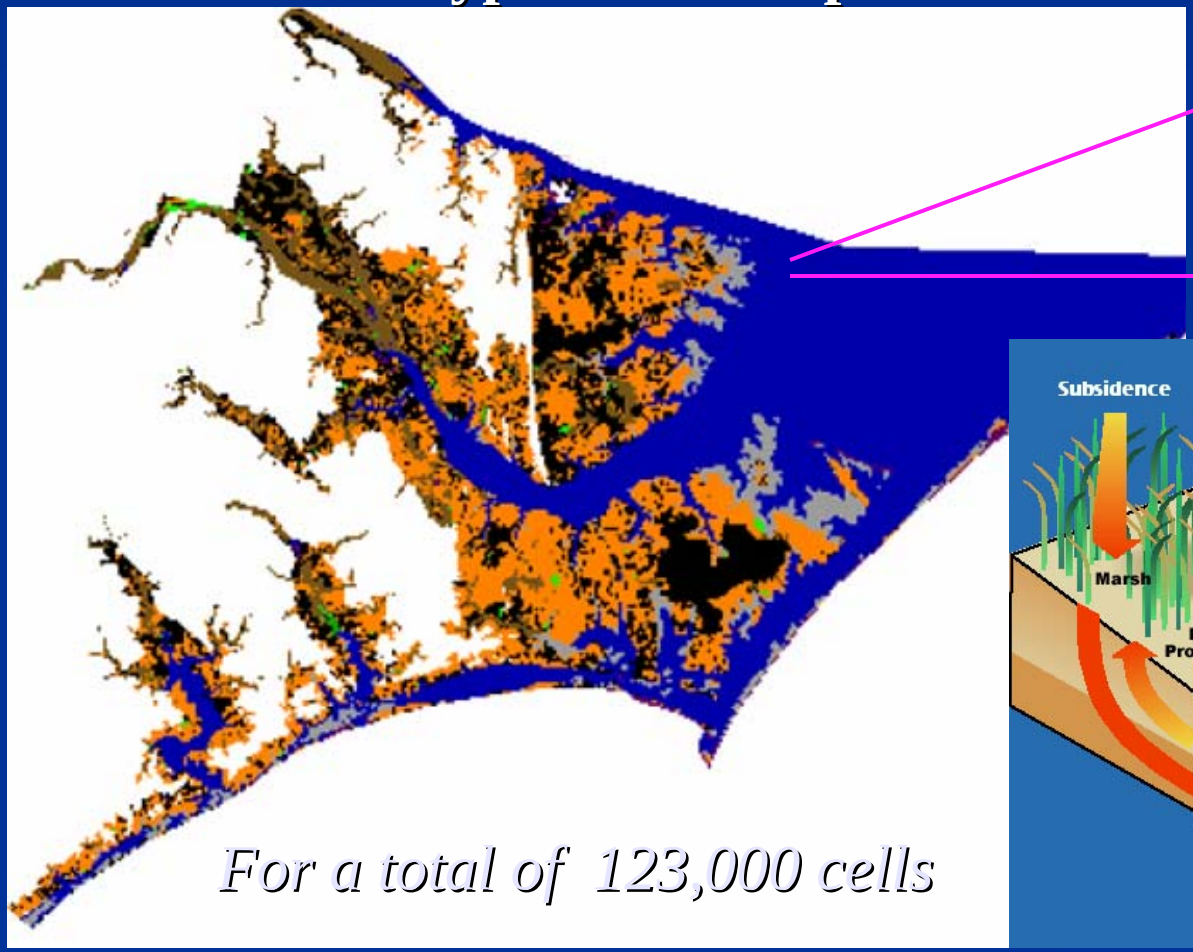
S RSET locations

Purse seine sets

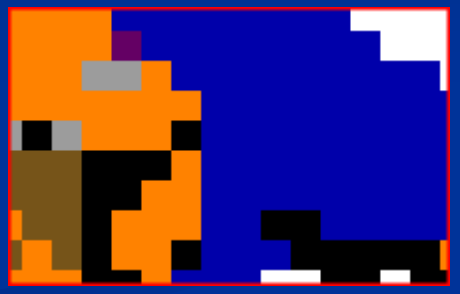
* RSET locations will be coordinated with plant colonization and expansion tasks such that a subset of established stands of tules and cattail will include both RSET stations and permanent sampling plots for vegetation and soil physico-chemical monitoring. In addition, other tasks including invertebrate and faunal components will be associated with these established stands to the extent that it is feasible

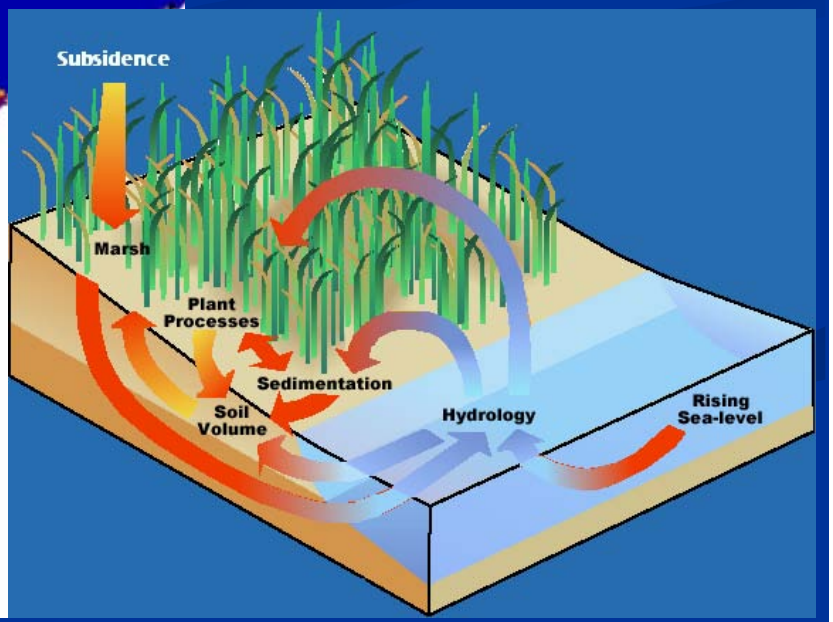
Landscape model

Each cell contains a *unit ecosystem model* representing a certain habitat type and incorporates location-specific algorithms.



For a total of 123,000 cells





Linkages to other studies

- BDCP process and modeling
- Restoration and flood management planning for Cache Slough and Yolo Bypass.
- USFWS Habitat Study Group (year round D smelt question)
- IEP – POD
- USGS regional sediment analysis
- DWR: Cache Slough and Yolo Bypass ecological analysis.

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There may be better fish in the water when it's troubled

Richard Grafton 1562